3. Sonographic Anatomy

We observed a seven-layer structure of the central airways. Differentiation of these structures is important in diagnosis of destruction by benign or malignant processes. Orientation within the mediastinum is difficult. Besides the complex anatomy and motion artifacts by respiration and pulsation this is mainly due to the unusual plains as we follow the airways. The vessels are easily recognized by their low echo and pulsation. Lymph nodes are more echo dense. The right atrium and mitral valve may be visualised from the left main bronchus. Close to the bifurcation the pulmonary artery, ascending aorta and aortic arch, the descending aorta, the aorto-pulmonary window, the esophagus and the vertebral column can be seen. Ventral to the right main bronchus the pulmonary artery, the aortic root and the vena cava are seen. Closer to the bifurcation the esophagus is found and laterally to the right the vena azygos and its junction with the vena cava. In the lower trachea the aortic arch and especially the brachiocephalic artery is easily seen. In the periphery conditions for echography are not favourable because of the surrounding air but sometimes solid structures and cystic formations can be differentiated.

4. Clinical application

Staging of Bronchial Carcinoma: Primary tumor–Early carcinoma

Frequently tumors that are not visible by high resolution CT scan are defined as early carcinoma. The patho-anatomical definition of early cancer is lack of infiltration beyond the submucosa. Only 75% of tumors that are visible by bronchoscopy are detected by radiology. In several patients with so called early bronchial carcinoma we saw advanced infiltration of the bronchial wall and even regional lymph nodes. In every case of alteration of the mucosa we found an altered sonographic structure and even if the mucosa seemed intact we sometimes found submucosal tumor spreading.

Intraluminal extent and involvement of the tracheobronchial wall
In complete airway obstruction we can differentiate the basis and the surface of the tumor and depth of invasion into the mediastinum. By passing the stenosis we could assess patency of the distal airways whether the pulmonary artery was occluded. In other patients we could see invasion of the pulmonary artery. Infiltration of mediastinal structures

Frequently we could diagnose infiltration of mediastinal organs as aorta, vena cava or main pulmonary artery. In several instances we could demonstrate direct infiltration of the esophageal wall. Intratracheal ultrasound was especially helpful in diagnosing infiltration of the tracheal wall by mediastinal tumors. Here endobronchial ultrasound proved to be superior to radiology. Involvement of lymph nodes

Under favorable conditions we could visualize lymph nodes down to a size of 2-3 mm and recognize lymph follicles, sinuses and lymph vessels. But even in a prospective in vitro study we were not able to find reliable signs for malignant infiltration. This is due to unspecific alterations as inflammatory reactions, silicotic or specific scar formation. Prior or simultaneous ultrasonography may reduce the number of attempts and improve results of transbronchial/transtracheal needle aspiration (TBNA). If invasion of the bronchial wall is seen a so called "button-hole"-biopsy can be safely performed. Large intrathoracic vessels

In early children we repeatedly detected vascular anomalies compromising the central airways. This was also the case in compression due to aortic aneurysm or for displacement after extensive surgical procedures. We were able to diagnose the rupture of a vascular flap for treatment of an aortic isthmic stenosis. Diagnosis of pulmonary embolism by endosonography is rare as this is no indication for an invasive procedure. This is also true for thrombosis of the pulmonary vein. Intrapulmonary Lesions

Only in some cases of atelectasis we were able to gain information by endosonography in differentiation of bronchial obstruction by lymph nodes or tumors from compression by pleural fluids or masses. Rarely endobronchial ultrasound may be helpful in guiding biopsy of peripheral lesions. In some cases we explored intrapulmonary cavities and found fungus balls or tumors of the wall. Pleural space and neighboring organs

If an atelectasis or pleural effusion provide an acoustic window we were able to see solid formations of the visceral and mediastinal pleura or on the pericardium. Endobronchial ultrasound proved to be extremely valuable in diagnosis of infiltration of the esophagus. Transesophageal exploration

In addition to endobronchial application we applied the probes in the esophagus for diagnosis of infiltration of the esophageal wall by bronchial carcinoma. Also benign intramural processes such as leiomyomas and intramural diverticulosis could be differentiated from malignant processes. Sometimes enlarged lymph nodes of the aortopulmonary window are detected more easily from the esophagus. Endobronchial Ultrasound In Interventional Bronchoscopy

In central airway stenosis sonography was useful for assessment of its extension and cause to chose the best method for intervention as dilatation, laser or stent implantation and control the therapeutic effect.

Especially in bronchoscopic treatment of malignant tumors with curative intent such as photodynamic therapy and brachytherapy endobronchial sonography proved superior to all other diagnostic procedures. 5. Conclusion and Future Aspects

In conclusion endobronchial ultrasound has become a valuable routine procedure in our institution. In prospective studies indications and results compared to conventional procedures have to be evaluated. Further improvements could include doppler sonography, computerized analysis of tissues and addition of a biopsy channel. In early detection of lung cancer endobronchial ultrasonography is an ideal instrument for local staging. We therefore believe that endobronchial ultrasound will be a routine procedure in the future and play an important role in diagnostic and interventional bronchoscopy.